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Endo

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(54) **EXPOSURE DEVICE, IMAGE FORMING APPARATUS AND MIRROR ADJUSTING METHOD**

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(51) **Int. Cl.**

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B41J 2/47	(2006.01)
B41J 2/435	(2006.01)

(52) **U.S. Cl.**
USPC **347/260**; 347/261; 347/237; 347/254; 347/240; 347/247

(58) **Field of Classification Search**
USPC 347/237, 247, 240, 254, 260, 261
See application file for complete search history.

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(57) **ABSTRACT**

An exposure device includes a mirror to reflect light used for exposure of an object, a holder to hold the mirror, an adhesive that bonds the mirror to the holder and elastically deforms, and an adjusting tool that pushes the mirror to change a direction of the mirror.

15 Claims, 8 Drawing Sheets

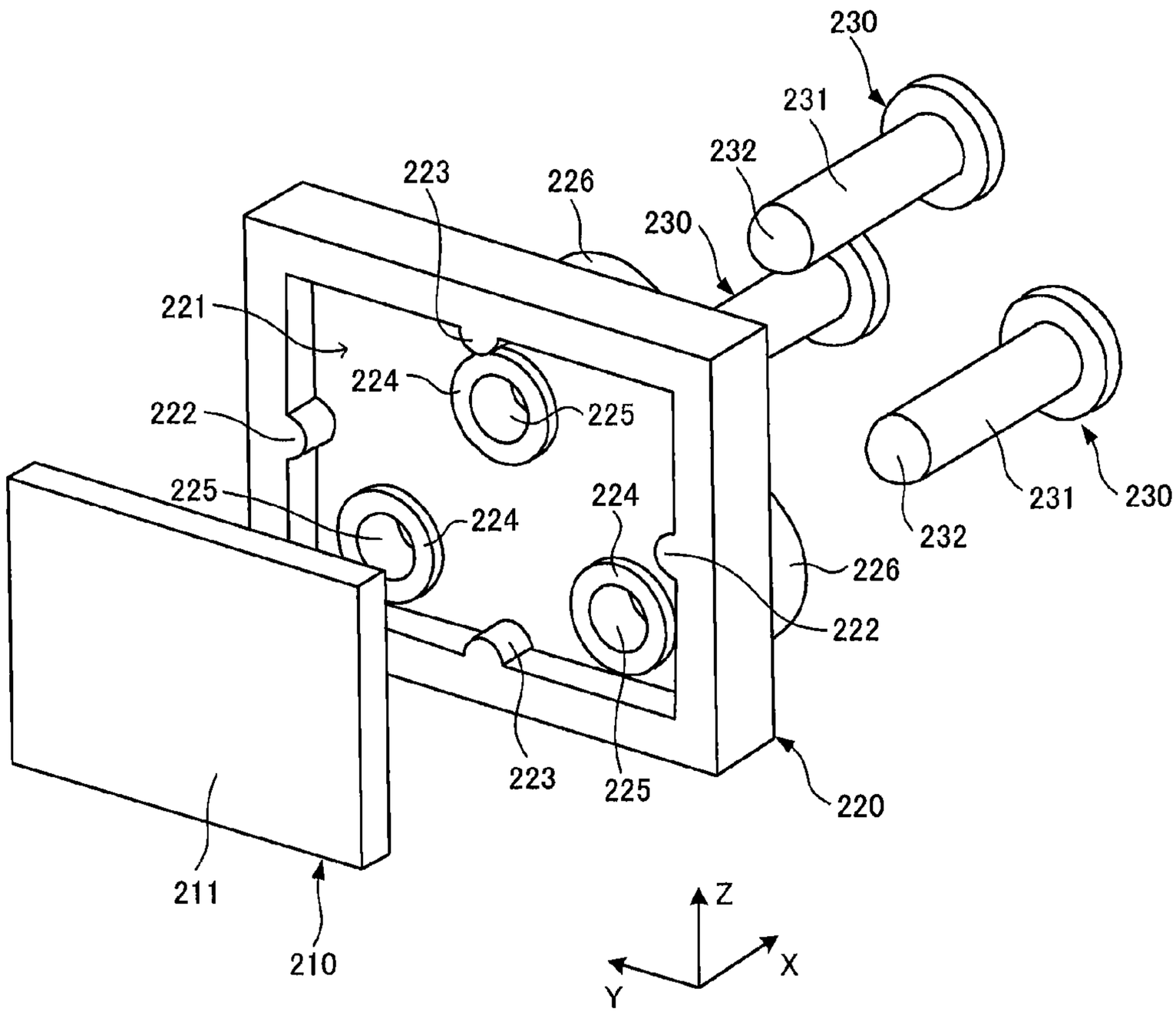
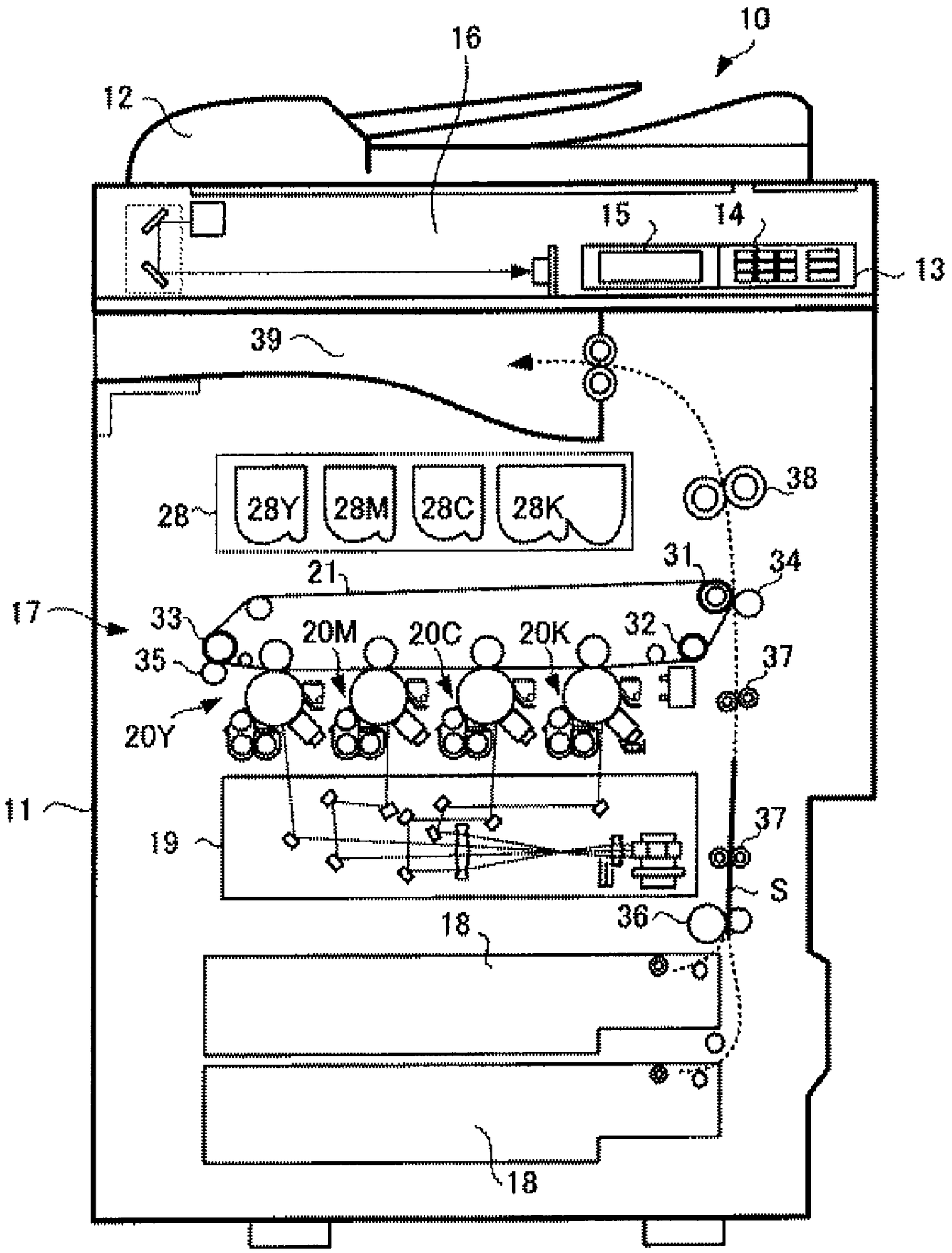


FIG. 1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20Y
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S
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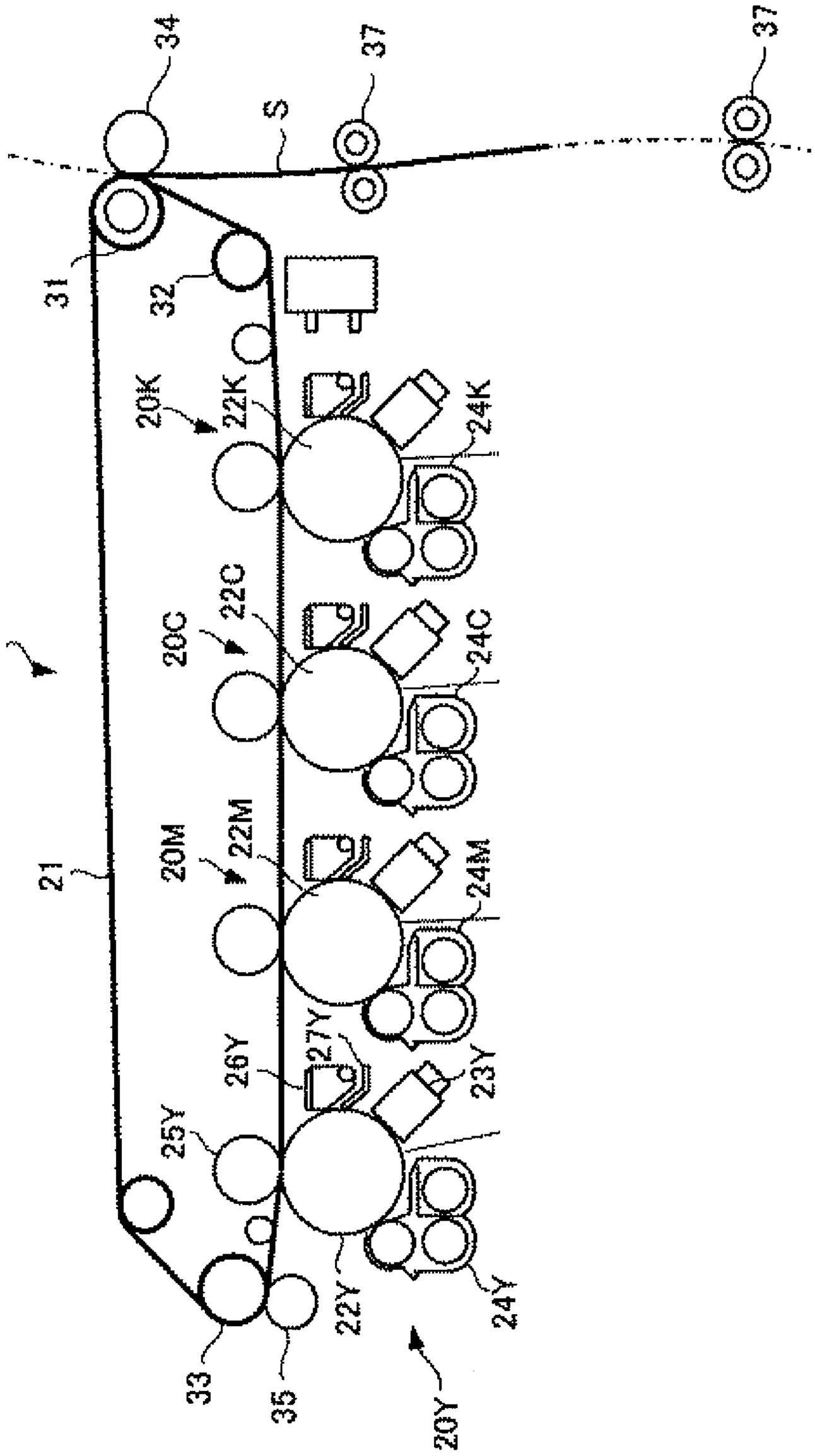
FIG. 2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22Y
24Y
33
35
20Y

FIG. 3

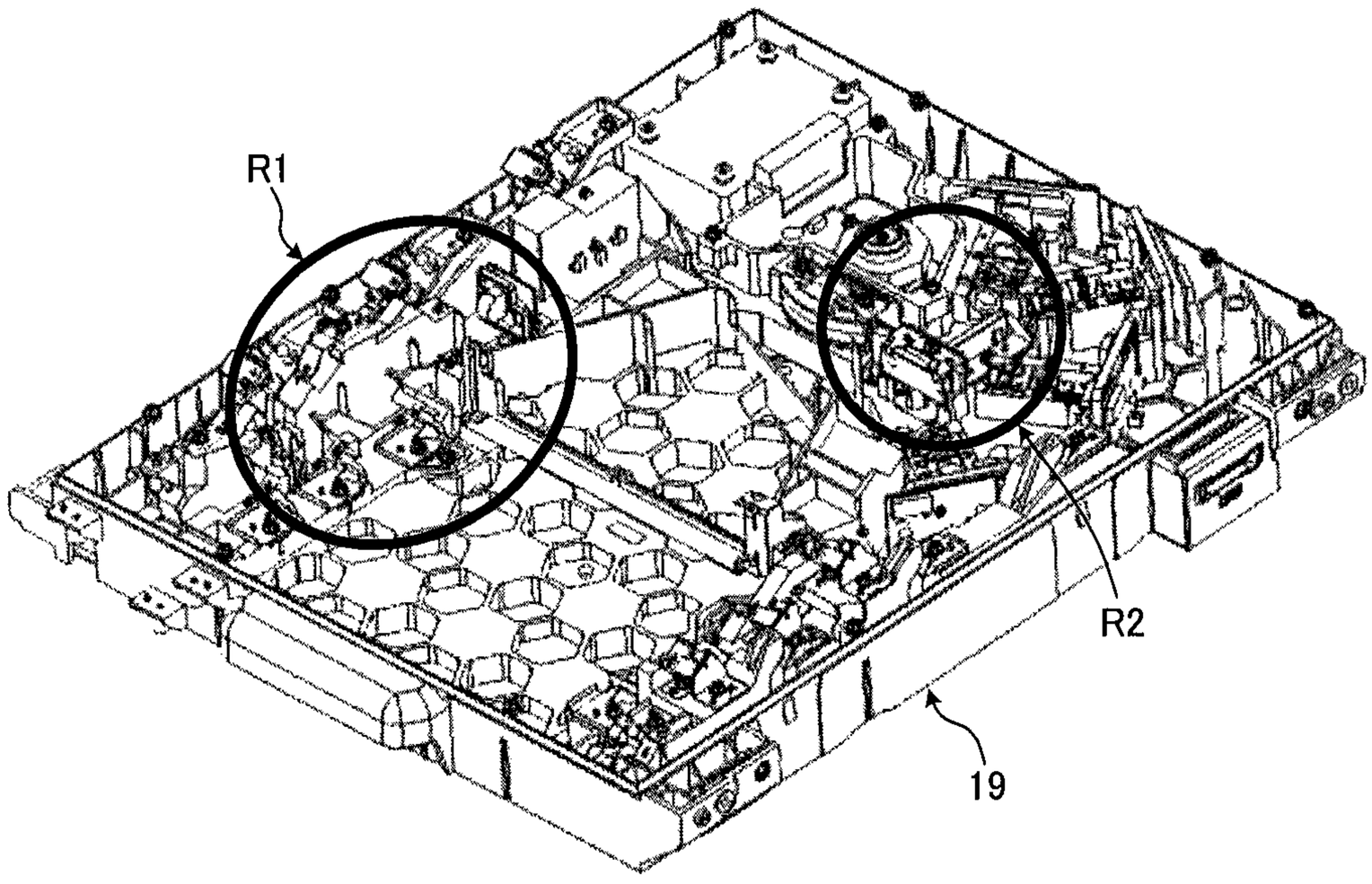


FIG. 4

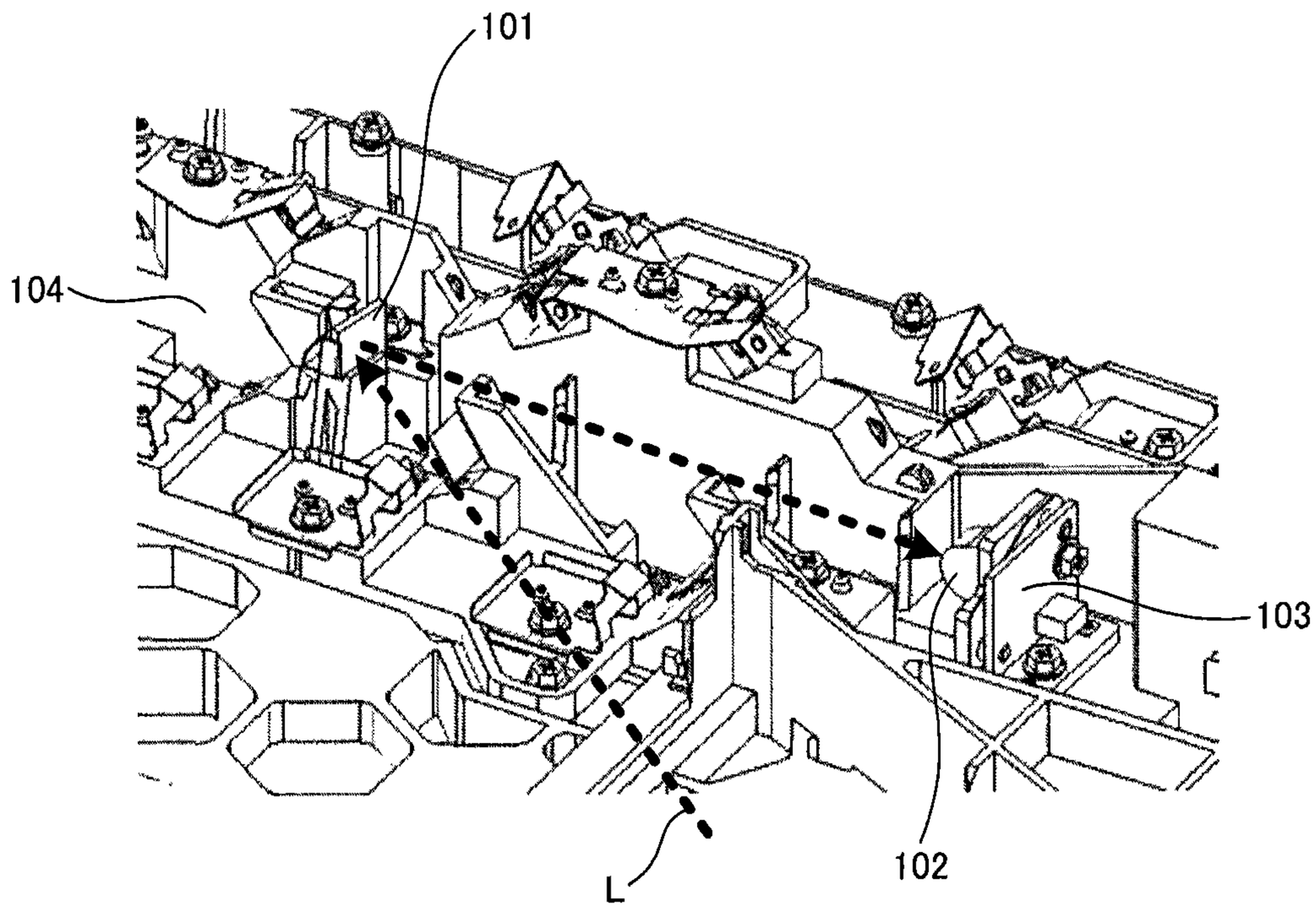


FIG. 5

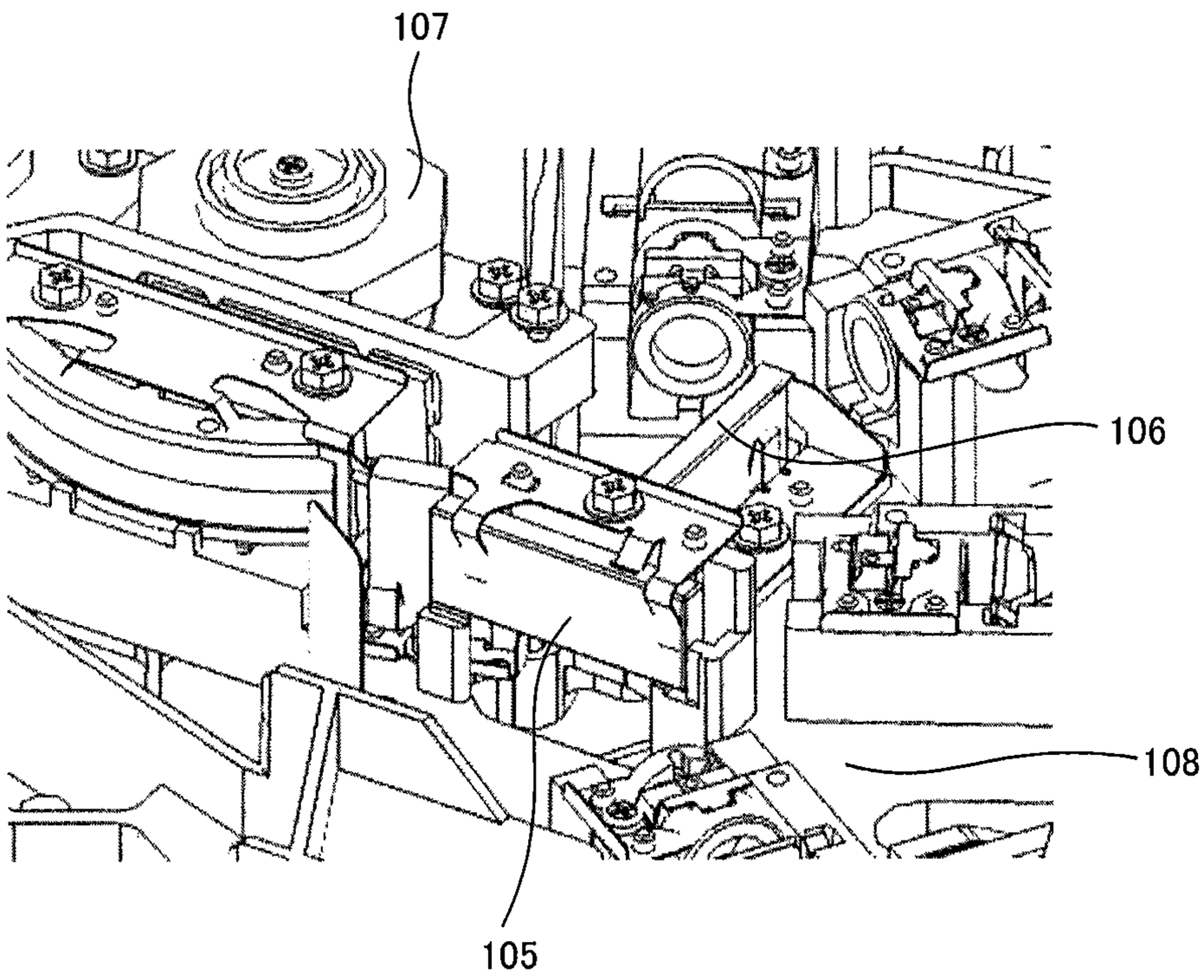
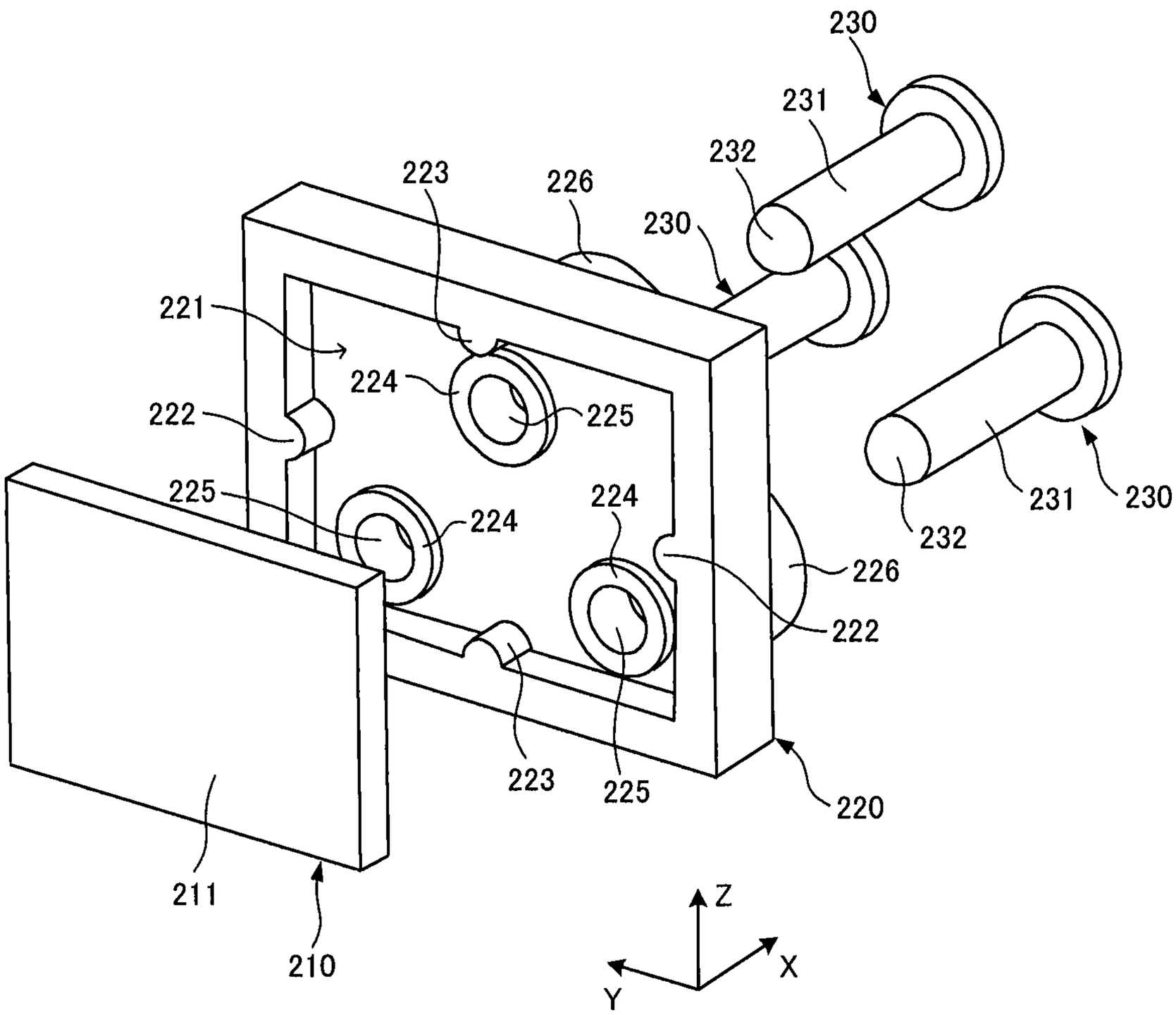


FIG. 6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211
210
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X
Y

FIG. 7

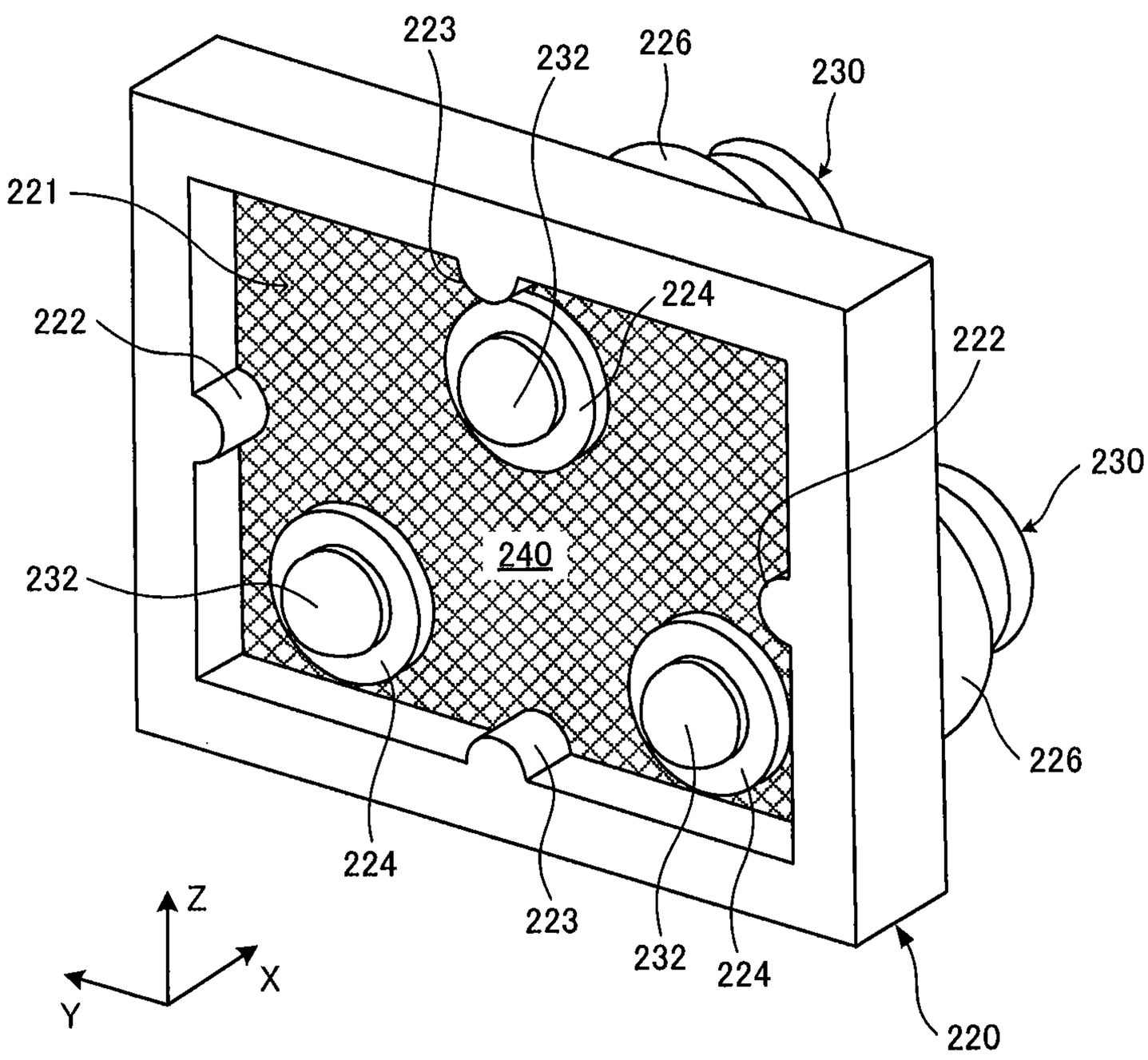
223
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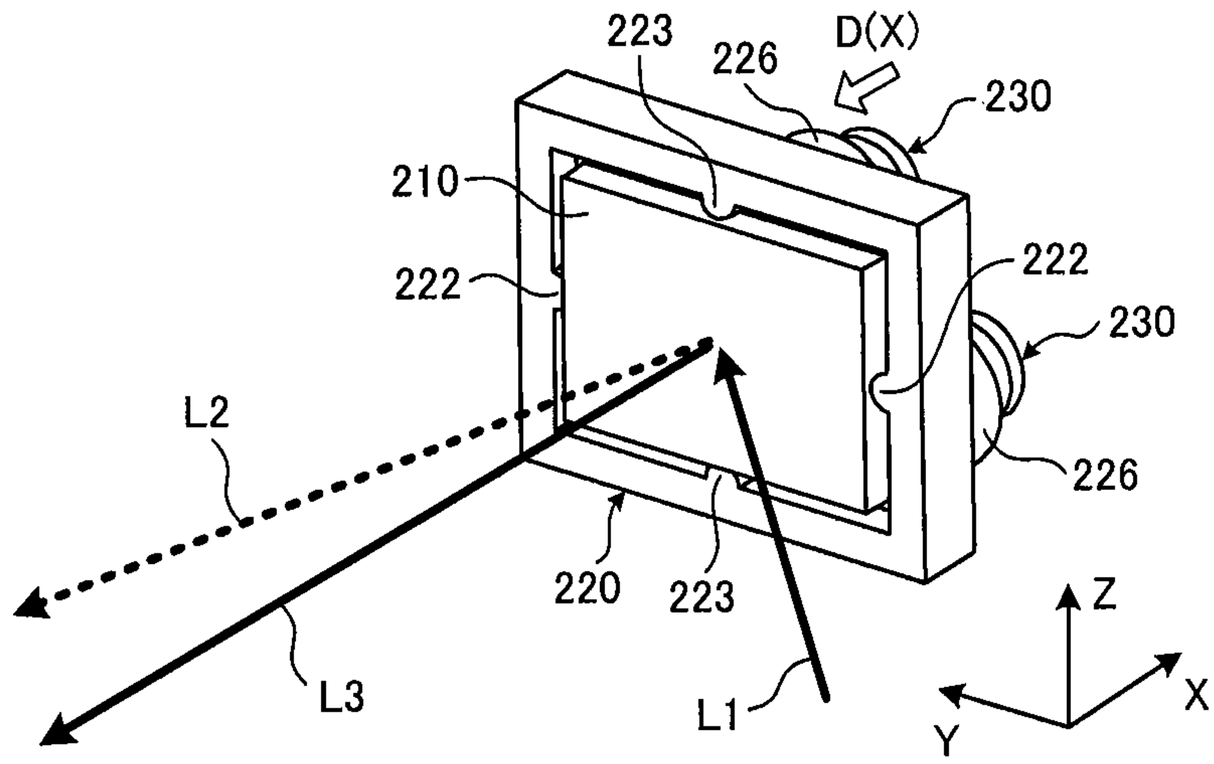
FIG. 8


223
226
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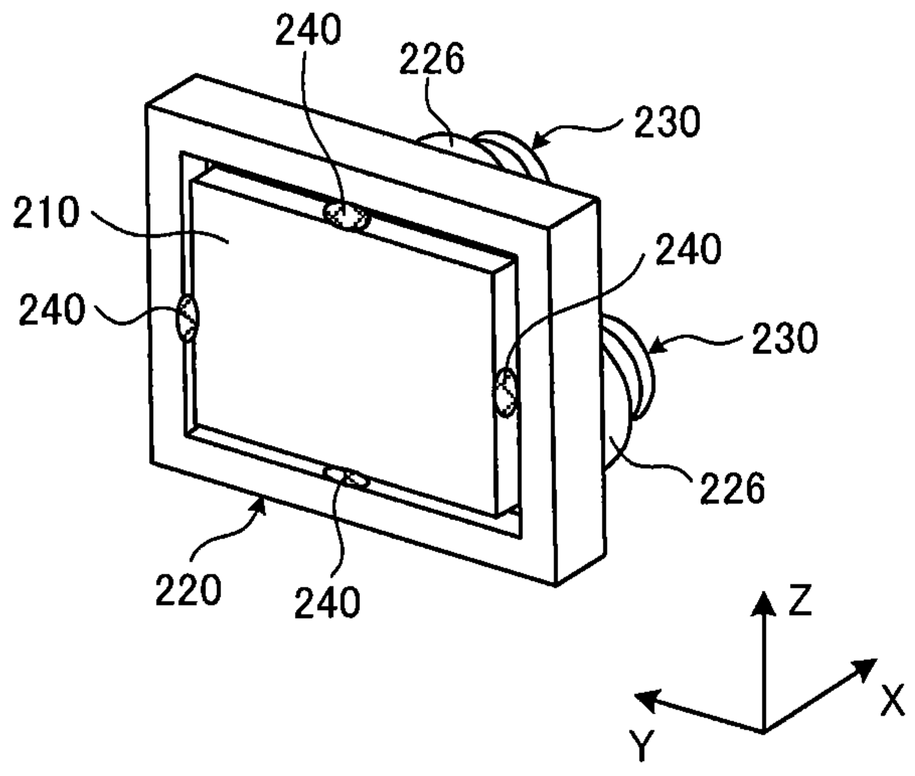
210
222
222
230
L2
226
220
223
Z
L3
L1
X
Y

FIG. 9


240
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EXPOSURE DEVICE, IMAGE FORMING APPARATUS AND MIRROR ADJUSTING METHOD

This application is also based upon and claims the benefit of priority from U.S. provisional application 61/326,555, filed on Apr. 21, 2010; the entire contents of which are incorporated herein by reference.

FIELD

Embodiments described herein relate generally to an exposure device, an image forming apparatus and a mirror adjusting method.

BACKGROUND

In an optical system in which light emitted from a light source reaches an object, a mirror is used. When a position where the mirror is mounted is shifted, or the light incident on the mirror is deviated, the direction (angle) of the mirror is required to be adjusted in order to cause the light reflected by the mirror to be sent in a specified direction.

DESCRIPTION OF THE DRAWINGS

FIG. **1** is a view showing an inner structure of an image forming apparatus.

FIG. **2** is a view showing a structure of a printer part.

FIG. **3** is a view showing a structure of a part of an exposure device.

FIG. **4** is an enlarged view of an area R**1** of FIG. **2**.

FIG. **5** is an enlarged view of an area R**2** of FIG. **2**.

FIG. **6** is an exploded view of a mirror unit of a first embodiment.

FIG. **7** is a view showing a structure of adjusting a direction of a mirror in the first embodiment.

FIG. **8** is a view for explaining a method of adjusting the direction of the mirror in the first embodiment.

FIG. **9** is an outer appearance view of a mirror unit of a second embodiment.

DETAILED DESCRIPTION

According to an embodiment, an exposure device includes a mirror to reflect light used for exposure of an object, a holder to hold the mirror, an adhesive that bonds the mirror to the holder and elastically deforms, and an adjusting tool that pushes the mirror to change a direction of the mirror.

First Embodiment

FIG. **1** is a view showing an inner structure of an image forming apparatus of a first embodiment. FIG. **2** is a view showing a structure of a printer part. A document table is provided at an upper part of a main body **11** of an image forming apparatus **10**, and an auto document feeder **12** is provided over the document table. The auto document feeder **12** feeds a document to the document table. An operation panel **13** is provided at an upper part of the main body **11**. The operation panel **13** includes an operation part **14** including various keys and a display part **15**.

A scanner **16** reads a document placed on the document table and generates image data. A printer part **17** forms an image corresponding to inputted image data onto a sheet. The image data includes image data generated by the scanner **16**, and image data transmitted from an external equipment such as a PC (Personal Computer) to the image forming apparatus **10**.

The printer part **17** includes image forming parts **20**Y, **20**M, **20**C and **20**K of respective colors of yellow (Y), magenta (M), cyan (C) and black (K). The image forming parts **20**Y to **20**K are disposed along an intermediate transfer belt **21**.

The image forming parts **20**Y to **20**K include photoconductive drums **22**Y to **22**K. A charging charger **23**Y, a developing unit **24**Y, a primary transfer roller **25**Y, a cleaner **26**Y and a blade **27**Y are disposed around the photoconductive drum **22**Y. Similarly to the photoconductive drum **22**Y, a charging charger and the like are disposed around the photoconductive drums **22**M to **22**K.

A laser beam irradiated from an exposure device **19** and corresponding to yellow reaches an exposure position of the photoconductive drum **22**Y. An electrostatic latent image is formed on the surface of the photoconductive drum **22**Y by the laser beam. The charging charger **23**Y charges the surface of the photoconductive drum **22**Y. The developing unit **24**Y supplies toner to the photoconductive drum **22**Y. The cleaner **26**Y uses the blade **27**Y and removes toner remaining on the surface of the photoconductive drum **22**Y.

A toner cartridge **28** is provided above the image forming parts **20**Y to **20**K. The toner cartridge **28** supplies toner to the developing units **24**Y, **24**M, **24**C and **24**K. The toner cartridge **28** includes toner cartridges **28**Y, **28**M, **28**C and **28**K containing toners of the respective colors of yellow (Y), magenta (M), cyan (C) and black (K).

The intermediate transfer belt **21** is stretched over a drive roller **31** and driven rollers **32** and **33**, and is in contact with the photoconductive drums **22**Y to **22**K. The primary transfer roller **25**Y applies a primary transfer voltage to the intermediate transfer belt **21** and transfers the toner image of the photoconductive drum **22**Y to the intermediate transfer belt **21**. The toner images of the photoconductive drums **22**M to **22**K are also transferred to the intermediate transfer belt **21** by the primary transfer roller.

A secondary transfer roller **34** is provided at a position opposite to the drive roller **31**. When a sheet S passes between the drive roller **31** and the secondary transfer roller **34**, the secondary transfer roller **34** applies a secondary transfer voltage to the intermediate transfer belt **21**, and transfers the toner images on the intermediate transfer belt **21** to the sheet S. A belt cleaner **35** is provided at a position opposite to the driven roller **33**.

The exposure device **19** irradiates and scans a laser beam corresponding to image information to the photoconductive drums **22**Y to **22**K. Electrostatic latent images corresponding to the respective colors (Y, M, C, K) are formed on the photoconductive drums **22**Y to **22**K by the laser beam.

The main body **11** includes plural paper feed cassettes **18**. The paper feed cassettes **18** contain plural sheets. A separation roller **36** takes out the sheet S contained in the paper feed cassette **18**. A conveyance roller **37** conveys the sheet from the paper feed cassette **18** to the secondary transfer roller **34**.

A fixing unit **38** heats the sheet S conveyed from the secondary transfer roller **34**, and fixes the image to the sheet S. The sheet passing through the fixing unit **38** is discharged to a tray **39**.

In this embodiment, a direction of a mirror is adjusted, and as the mirror, there is a mirror used in the exposure device **19**. FIG. **3** is an outer appearance view of a part of the exposure device **19**, and mirrors are arranged in portions surrounded by areas R**1** and R**2**.

FIG. **4** is an enlarged view of the area R**1** of FIG. **3**. A mirror **101** reflects a laser beam L scanned by a polygon mirror to a condenser lens **102**. The condenser lens **102** focuses the laser beam L from the mirror **101** on a horizontal synchronization sensor **103**.

The horizontal synchronization sensor **103** receives the laser beam L, and outputs a horizontal synchronization signal. A case **104** of the exposure device **19** holds the mirror **101**, and can be formed of, for example, resin.

FIG. **5** is an enlarged view of the area R**2** of FIG. **3**. Mirrors **105** and **106** reflect a laser beam from a corresponding light source to a polygon mirror **107**. A case **108** of the exposure device **109** holds the mirrors **105** and **106**, and can be formed of, for example, metal (aluminum die casting).

A structure of adjusting the direction of the mirror will be described. FIG. **6** is an exploded view of a mirror unit. In FIG. **6**, an X-axis, a Y-axis and a Z-axis are axes perpendicular to each other. The relation between the X-axis, the Y-axis and the Z-axis is the same also in FIG. **7** and FIG. **8**.

A holder **220** holds a mirror **210**. The mirror **210** corresponds to the mirror **101**, **105** or **106** explained in FIG. **4** and FIG. **5**. A surface **211** of the mirror **210** is a reflecting surface to reflect a laser beam. In this embodiment, although the surface **211** of the mirror **210** is a flat surface, the surface **211** may be a curved surface. The curved surface may be a concave surface or a convex surface.

The holder **220** includes a containing part **221** to contain the mirror **210**. The holder **220** includes four projections **222** and **223** in an area surrounding the mirror **210**. The projections **222** and **223** protrude to the inside of the holder **220**, and contact the outer edge (side surface) of the mirror **210**.

The two projections **222** contact the mirror **210**, so that the mirror **210** can be positioned in the Y direction. The two projections **223** contact the mirror **210**, so that the mirror **210** can be positioned in the Z direction.

In this embodiment, although the projections **222** and **223** are provided at the positions corresponding to the four sides of the mirror **210**, the positions where the projections **222** and **223** are provided and the number thereof can be appropriately set. It is sufficient if the mirror **210** can be positioned in at least one of the Y direction and the Z direction.

For example, only the projections **222** may be provided, or only the projections **223** may be provided. In this embodiment, although the two projections **222** are opposite to each other in the Y direction, the two projections **222** may not be opposite to each other in the Y direction. The two projections **223** may also not be opposite to each other in the Z direction.

The holder **220** includes three first cylindrical parts **224** at the inside of the containing part **221**. The first cylindrical part **224** extends in the X direction, and a screw groove **225** is formed on the inner surface of the first cylindrical part **224**. Three second cylindrical parts **226** are provided on the outer surface of the holder **220**, and the second cylindrical parts **226** extend in the X direction.

The second cylindrical part **226** is provided on an extended line of the first cylindrical part **224**. The screw groove **225** passes through the holder **220**, and is also formed on the inner peripheral surface of the second cylindrical part **226**.

A pin **230** as an adjusting tool includes a screw part **231** engaging with the screw groove **225**. A tip **232** of the pin **230** is formed of a curved surface (hemisphere face). The pin **230** is inserted into the screw groove **225** from the side of the second cylindrical part **226**. When the pin **230** rotates in the state where the screw part **231** and the screw groove **225** are engaged with each other, the tip **232** of the pin **230** protrudes from the tip of the first cylindrical part **224** (see FIG. **7**).

When the position where the screw groove **225** engages with the screw part **231** is changed, the pin **230** can be moved in the X direction with respect to the holder **220**. When the pin **230** is moved in the X direction, the protrusion amount of the pin **230** from the first cylindrical part **224** can be changed.

The tip **232** of the pin **230** protruding from the first cylindrical part **224** contacts the mirror **210**. Specifically, the tip **232** of the pin **230** contacts a rear surface of the mirror **210**. The rear surface of the mirror **210** is the surface opposite to the front surface (reflecting surface) **211** in the X direction. The rear surface of the mirror **210** is a flat surface.

As shown in FIG. **7**, an adhesive **240** is applied to the containing part **221**. The thickness (length in the X direction) of the layer of the adhesive **240** is equal to the length of the first cylindrical part **224** in the X direction. Accordingly, the adhesive **240** does not enter the inside of the first cylindrical part **224** and does not contact the pin **230**.

The adhesive **240** applied to the containing part **221** contacts the rear surface of the mirror **210**. The adhesive **240** bonds the mirror **210** to the holder **220**. The adhesive **240** used in this embodiment can elastically deform after the adhesive **240** is cured.

As the adhesive **240**, for example, the adhesive shown in Table 1 can be used.

TABLE 1

Manufacturing company	Product name	Main ingredient	Bonding strength	Extension
Cemedine Co., Ltd.	PM100	Modified silicone	0.91 [N/mm^2]	200[%]
	PM155	Epoxy + Modified silicone	2.1 [N/mm^2]	180[%]
	PM165	Modified silicone	2.1 [N/mm^2]	100[%]
	PM300	Ethyl cyanoacrylate	2.0 [N/mm^2]	170[%]
	PM200	Epoxy + Modified silicone	5.4 [N/mm^2]	140[%]
	Super X	Acrylic modified silicone	3.7 [N/mm^2]	220[%]
ThreeBond Co., Ltd.	1530	Special polymer containing silyl group	5.9 [MPa]	280[%]
	1530B	Special polymer containing silyl group	3.0 [MPa]	380[%]
	1530C	Special polymer containing silyl group	4.1 [MPa]	200[%]
	1532	Modified silicone	1.8 [MPa]	360[%]

The bonding strength shown in Table 1 includes tensile bonding strength and shear bonding strength. The tensile bonding strength is a tensile load per unit area when the adhesion is broken when a tensile force acts in a direction perpendicular to the adhesive surface of the adhesive. The shear bonding strength is the magnitude of force when the adhesion is broken when the force acts in a direction parallel to the adhesive surface of the adhesive.

The movement amount of the mirror **210** when the direction of the mirror **210** is adjusted, the bonding strength and the extension of the adhesive **240** are considered, and the specific adhesive **240** can be determined.

After the holder **220** and the mirror **210** are bonded to each other by the adhesive **240**, when at least one pin **230** of the three pins **230** is moved in the X direction, the direction of the mirror **210** can be changed.

Specifically, when the pin **230** is moved in the X direction and pushes the mirror **210**, the direction of the mirror **210** can be changed. The adhesive **240** to bond the mirror **210** to the holder **220** is deformed according to the change of the direc-

tion of the mirror **210**. A part of the adhesive **240** expands according to the displacement of the mirror **210**.

In FIG. **8**, among the three pins **230**, only one pin **230** positioned above is moved in an arrow D (X) direction. Before the pin **230** is moved in the arrow D (X) direction, a laser beam L**1** incident on the mirror **210** is reflected by the mirror **210** and advances along an optical path L**2**.

After the pin **230** is moved in the arrow D (X) direction, the laser beam L**1** incident on the mirror **210** is reflected by the mirror **210** and advances along a light path L**3**. As shown in FIG. **8**, the direction of the mirror **210** is changed by moving the pin **230** in the arrow D (X) direction, and the movement direction of the laser beam reflected by the mirror **210** can be changed.

According to this embodiment, among the three pins **230**, at least one pin **230** is moved in the X direction and pushes the mirror **210**, so that the direction of the mirror **210** can be changed. When the three pins **230** are used, the direction of the mirror **210** can be changed in various directions.

Since the tip **232** of the pin **230** is formed of the curved surface (convex surface), even if the direction of the mirror **210** is changed, a part of the tip **232** can be kept to contact the mirror **210**. When the three pins **230** are moved in the same direction by the same amount, the mirror **210** can be moved in the X direction without changing the direction of the mirror **210**.

Even if the pin **230** pushes the mirror **210**, since the mirror **210** and the holder **220** remain to be bonded by the adhesive **240**, the mirror **210** does not come off from the holder **220**. The pin **230** can be held at a desired position by engaging the screw part **231** of the pin **230** with the screw groove **225**.

The protrusion amount of the pin **230** from the first cylindrical part **224** can be finely adjusted according to the rotation amount of the pin **230**. When the protrusion amount of the pin **230** is finely adjusted, the direction of the mirror **210** can be finely adjusted.

In this embodiment, although the adhesive **240** is applied to the whole area of the containing part **221** except for the first cylindrical parts **224**, the area to which the adhesive **240** is applied can be appropriately set. It is sufficient if the adhesive **240** bonds the mirror **210** to the holder **220**, and can allow the movement of the mirror **210** by the elastic deformation. The adhesive **240** can be applied to only a partial area of the area of the containing part **221** except for the first cylindrical parts **224**

Second Embodiment

A mirror unit of a second embodiment will be described. FIG. **9** is an outer appearance view of the mirror unit.

In the first embodiment, the adhesive **240** is applied to the containing part **221** of the holder **220**. However, in this embodiment, as shown in FIG. **9**, an adhesive **240** is applied to an outer edge of a mirror **210**.

In this embodiment, the adhesive **240** is not applied to the containing part **221** of the holder **220**. Accordingly, in the holder **220** of this embodiment, the first cylindrical parts **224** explained in the first embodiment can be omitted. Besides, in this embodiment, the projections **222** and **223** explained in the first embodiment are omitted.

As shown in FIG. **9**, the adhesive **240** is applied to four places of the outer edge of the mirror **210**. The adhesive **240** bonds the mirror **210** to the holder **220**. The adhesive **240** is applied to the four places, so that the mirror **210** can be positioned in the Y-Z plane.

In this embodiment, although the adhesive **240** is applied to two positions opposite to each other in the Z direction and two positions opposite to each other in the Y direction, the position to which the adhesive **240** is applied can be appropriately set. It is sufficient if the adhesive **240** bonds the mirror **210** to the holder **220**, and allows the movement of the mirror **210** by the elastic deformation.

According to this embodiment, the pin **230** is moved in the X direction and pushes the mirror **210**, so that the direction of the mirror **210** can be changed.

In the first embodiment and the second embodiment, although the pin **230** provided with the screw part **231** is used, a pin provided with another structure may be used. It is sufficient if the pin can be moved in the X direction, and can be fixed to the holder **220** at specified positions (plural positions) in the X direction.

For example, the pin **230** is provided with a plate spring, and plural grooves engaging with the plate spring are provided in the holder **220**. The position of the pin in the X direction can be adjusted by changing the position where the plate spring engages with the groove. The direction of the mirror **210** can be adjusted by adjusting the position of the pin in the X direction.

In the first embodiment and the second embodiment, although the three pins **230** are used and the direction of the mirror **210** is adjusted, the positions where the pins **230** are disposed and the number thereof can be appropriately set.

Specifically, one pin **230** is used, and the direction of the mirror **210** can be adjusted. For example, in a structure in which the tip **232** of the pin **230** contacts a portion deviated from the center of the mirror **210**, when the pin **230** pushes the mirror **210**, the direction of the mirror **210** can be changed. The center of the mirror **210** is the center of the mirror **210** on the Y-Z plane.

Even when two pins **230** are used, the direction in which the direction of the mirror **210** is changed can be changed according to the positions where the two pins **230** are disposed.

In addition to the structure of the first embodiment and the second embodiment, the holder **220** can be provided with a stopper. The stopper contacts the mirror **210**, and prevents the mirror **210** from being displaced by a specified amount or more. The stopper can be provided on the surface of the holder **220** on which the containing part **221** is formed.

The movement amount of the pin **230** in the X direction can be limited by using the second cylindrical part **226**. Specifically, the length of the second cylindrical part **226** in the X direction and the length of the pin **230** in the X direction are appropriately determined, so that the protrusion amount (maximum value) of the pin **230** from the first cylindrical part **224** can be determined. When the protrusion amount (maximum value) of the pin **230** is determined, it is possible to prevent the pin **230** from pushing the mirror **310** until the adhesion of the adhesive **240** is broken.

While certain embodiments have been described, these embodiments have been presented by way of example only, and are not intended to limit the scope of invention. Indeed, the novel embodiments described herein may be embodied in a variety of other forms; furthermore, various omissions, substitutions and changes in the form of the embodiments described herein may be made without departing from the spirit of the inventions. The accompanying claims and their equivalents are intended to cover such forms or modifications as would fall within the scope and spirit of the inventions.

What is claimed is:

1. An exposure device comprising:

a mirror to reflect light used for exposure of an object;

a holder to hold the mirror;

an adhesive that bonds the mirror to the holder and elastically deforms; and

an adjusting tool configured to move the mirror to change a reflecting direction of the mirror, a tip of the adjusting tool contacting the mirror, and including a curved surface protruding to the mirror.

2. The device of claim **1**, wherein the adjusting tool includes a screw part to engage a screw hole formed in the holder.

3. The device of claim **1**, wherein the adjusting tool is supported by the holder and is movable relative to the holder.

4. The device of claim **1**, wherein a plurality of the adjusting tools are provided.

5. An exposure device comprising:

a mirror to reflect light used for exposure of an object;

a holder to hold the mirror;

an adhesive that bonds the mirror to the holder and elastically deforms; and

an adjusting tool that contacts a surface of the mirror opposite to a reflecting surface and is configured to move the mirror to change a reflecting direction of the mirror.

6. The device of claim **5**, wherein the adhesive contacts the surface of the mirror opposite to the reflecting surface.

7. The device of claim **6**, wherein the holder includes a containing part to contain the adhesive.

8. The device of claim **5**, wherein the adjusting tool is supported by the holder and is movable relative to the holder.

9. The device of claim **5**, wherein the adjusting tool includes a screw part to engage a screw hole formed in the holder.

10. The device of claim **5**, wherein the adjusting tool includes a plurality of adjusting tools.

11. An exposure device comprising:

a mirror to reflect light used for exposure of an object;

a holder to hold the mirror and including a projection to position the mirror in a plane parallel to a reflecting surface of the mirror;

an adhesive that bonds the mirror to the holder and elastically deforms; and

an adjusting tool configured to move the mirror to change a direction of the mirror.

12. An image forming apparatus comprising:

a photoreceptor;

a mirror to reflect light used for exposure of the photoreceptor;

a holder to hold the mirror;

an adhesive that bonds the mirror to the holder and elastically deforms;

an adjusting tool configured to move the mirror to change a reflecting direction of the mirror, a tip of the adjusting tool contacting the mirror, and including a curved surface protruding to the mirror; and

a developing unit to supply toner to the photoreceptor.

13. An image forming apparatus comprising:

a photoreceptor;

a mirror to reflect the light used for exposure of the photoreceptor;

a holder to hold the mirror;

an adhesive that bonds the mirror to the holder and elastically deforms;

an adjusting tool that contacts a surface of the mirror opposite to a reflecting surface and is configured to move the mirror to change a reflecting direction of the mirror; and

a developing unit to supply toner to the photoreceptor.

14. The apparatus of claim **13**, wherein the adhesive contacts the surface of the mirror opposite to the reflecting surface.

15. The apparatus of claim **14**, wherein the holder includes a containing part to contain the adhesive.

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